MEMORANDUM

To: Kara Vuicich
From: Adam Millard-Ball and Jessica ter Schure
Date: April 12, 2006
Subject: Recommended refinements to trip generation methodology

This memorandum provides recommendations for a trip generation methodology for use in traffic impact analysis reports and when determining the level of the proposed Transportation Services Fee (TSF). It includes work already completed by staff on identifying base reductions per census tract, and extends this to provide a list of recommended reductions for specific trip reduction measures.

Why does Berkeley need a Trip Generation Methodology?

The Institute of Transportation Engineers’ Trip Generation is the customary reference for figuring the number of vehicle trips likely to be produced by a given amount of development. The manual draws on more than 4,250 empirical studies and includes information on 150 different land uses. However, as the companion Trip Generation Handbook reports, “The data contained in Trip Generation are, by definition, from single-use developments where virtually all access is by private automobile and all parking is accommodated on site.”

Why is this true by definition? ITE’s recommended site-selection procedures for a trip-generation study declare that it should be possible to isolate the site for counting purposes. Therefore, selected sites must have “no shared parking (unless the parking areas for the site are easily distinguishable); no shared driveways (unless the driveways for the site are easily distinguishable); limited ability for pedestrians to walk into the site from nearby parcel; [and] limited transit availability or use (unless transit usage can be counted—e.g., elementary students to ride a school bus).”1

These procedures rule out counting the typical traditional mixed-use neighborhoods typical to Berkeley which, for ITE, have too much shared on-street parking, too much walking from place to place, and too much transit. While ITE has the largest trip generation database, its figures need to be adjusted downwards for these factors before being used in a context such as Berkeley.

Indeed, the user’s guide for *Trip Generation* already advises: “At specific sites, the user may wish to modify trip generation rates presented in this document to reflect the presence of public transportation service, ridesharing or other TDM measures, enhanced pedestrian and bicycle trip-making opportunities, or other special characteristics of the site or surrounding area.”

**Potential Approaches**

There are four broad approaches that Berkeley could consider when developing a methodology for estimating the number of trips generated by a new development:

- **Staff discretion.** One option is for staff to use professional judgment when determining the level of any trip reduction to be applied on a case-by-case basis. This is similar to the process currently used in Berkeley. It is the most flexible and easiest to implement, but is not recommended following TSF implementation because: (i) it does not provide any certainty for the developer when determining the optimum trip reduction plan; and (ii) it could lead to conflict between the City and developers, since each trip reduced will have a large monetary value.

- **Conservative research-based.** This is similar to the approach adopted by the Valley Transportation Authority in Santa Clara County. Reductions of up to 30% are granted for clearly defined measures such as providing a mix of uses, dedicated shuttle service or locating close to transit. The reductions are below the level of what might be expected, but are within the bounds of what has clearly been established by research and do provide certainty for developers.

- **Policy incentives.** This approach is used by C/CAG in San Mateo County, which provides a “long list” of trip reduction measures for which large developers can be granted credit. These measures are only loosely based on research, and developers that combine multiple measures may be granted trip reductions far in excess of what might reasonably be expected. For this reason, this approach can be characterized as providing policy incentives for trip reduction, rather than seeking to accurately quantify the precise impacts.

- **Monitoring and enforcement.** Seattle, South San Francisco and Montgomery County, MD are examples of this approach. Forecast trip generation is less critical, and so planners and developers can be more aggressive in projecting the impacts of measures for which there are fewer solid research results. However, post-occupancy monitoring counts are used to ensure that the forecast trip reductions are being achieved; if not, additional measures can be required. This approach is the most comprehensive, but does require significant staff resources for enforcement. It is perhaps most appropriate for larger projects than those likely to be seen in Berkeley.

The approach adopted in the remainder of these memorandum falls somewhere between the second and third options. The recommended reductions aim to strike a balance between a firm rooting in published research, while not precluding the inclusion of desirable measures for which there is less information on the impacts. Most importantly, the trip reductions are designed to be clear, predictable and readily understandable to staff and developers, even if this comes somewhat at the expense of precision.
Proposed Methodology

The proposed methodology consists of two steps, each of which is discussed in more detail below:

- **Neighborhood adjustment.** The first step is to adjust the number of trips for neighborhood characteristics. This accounts for factors such as the quality of the pedestrian environment, bicycle facilities, transit service, on-street parking constraints, mix of uses and density, which are largely independent of an individual development.

- **Additional trip reductions.** The second step is to adjust for site-specific trip reduction measures which are not captured in the neighborhood adjustment, such as reduced parking, charges for parking, shuttles and secure bicycle parking.

**Neighborhood Adjustment**

The level of adjustment depends on the type of use (residential or non-residential) and, for residential uses, the type of trip (work or non-work). Figure 1 shows the data source for each type of use and trip. Where available (i.e. for home-based work trips), census data are used; in other cases, Metropolitan Transportation Commission model forecasts are used.

This methodology does provide a large range of reductions, which illustrate the diverse geography of Berkeley’s neighborhoods. For example, the U.C. campus (census tract 4226) and the South Side (4228) have the lowest journey to work mode share for single-occupant vehicle (2% and 17% respectively). There are several other areas with low SOV mode shares, particularly in downtown where SOV mode shares are around one-third. The highest journey to work SOV mode shares are in the Berkeley Hills. A similar pattern of reductions is seen with the MTC forecast data.

Two issues relate to geography:

- **MTC data is provided by Traffic Analysis Zone (TAZ), and census data by census tract. The two geographies are similar but not identical.** For simplicity and ease of use, we recommend that the geographies be consolidated and mapped. Each census tract (or other standardized geography) would list two percentage reductions – one for home-based work trips, and one for other trips.

- **Tract boundaries generally follow major transportation routes,** which often are also the major bus corridors in Berkeley. Since tracts tend to be approximately ½ mile across, while the impacts of good bus service are most pronounced within ¼ mile, this means that developments close to key transit corridors may be undercredited for their transit access. Since primary transit routes on the South Side are closely spaced (such as the Telegraph Ave and College Ave services), this is primarily an issue for the San Pablo Rapid Bus. An additional reduction is recommended for developments within ¼ mile of a Rapid Bus stop, discussed in the following section.
Figure 1  
Source of Neighborhood Adjustment Data

<table>
<thead>
<tr>
<th>Source of Data</th>
<th>Residential</th>
<th>Non-Residential</th>
</tr>
</thead>
<tbody>
<tr>
<td>Journey to work</td>
<td>U.S. Census</td>
<td>MTC forecasts for mode split</td>
</tr>
<tr>
<td>Other trips</td>
<td>MTC forecasts for mode split</td>
<td>MTC forecasts for mode split</td>
</tr>
</tbody>
</table>

Additional Trip Reductions

Figure 2 shows the reductions that are recommended for specific on-site trip reduction measures. In general, these are limited to those measures where there is good research data on the trip reduction impacts. The recommended reductions tend to be lower than those that might be supported by the literature, in order to avoid double counting with the neighborhood adjustment (which, particularly in downtown, will already factor in some of these programs). Unless noted in the text below, all reductions are combinable and additive.

The first set of measures listed in Figure 2 applies to all types of development. The second and third sets apply only to residential and non-residential projects respectively. Developers that implement all these programs would receive total credits of up to about 25% for residential projects and 30% for non-residential projects, on top of the neighborhood adjustment. However, note that the neighborhood adjustment and additional trip reductions are multiplicative (e.g. a 20% neighborhood reduction and 25% additional reduction would give a total reduction of 40%). Car-free housing could receive a total trip reduction of 95%. A brief discussion of each potential measure follows:

All Project Types

- **EcoPass Program:** An additional reduction of 10% of the neighborhood adjustment for developers that commit to providing free transit passes. This credit is thus more valuable in neighborhoods that have good levels of transit service.

- **Car-Sharing:** A 2% credit for developers that both provide free memberships for residents and employees, and make free parking available for car-sharing vehicles.

- **Secure Bicycle Parking:** An additional reduction of 1% of the neighborhood adjustment for providing bicycle lockers or cages. Bicycle racks are already required under City Code.

- **Shuttle Service:** A 2-3% reduction for projects that provide or contribute to shuttle service (such as the West Berkeley shuttle).

- **Proximity to Transit:** A 1% reduction for projects close to San Pablo Rapid bus stops. (Reductions for BART and other AC Transit lines are already factored in the neighborhood adjustment.)

- **TDM Program:** Up to 3% for implementing other TDM measures, such as employing a transportation coordinator, providing lockers and showers for cyclists, or joining a Transportation Management Association (TMA).
Residential Projects Only

- **Housing with Less Parking:** A reduction of up to 95% for residential projects with less than 1:1 parking. This reduction is *not* combinable with other credits or the neighborhood adjustment.

- **Unbundled parking:** A 10% credit for developers that charge at least $100/space/month for residential parking.

Non-Residential Projects Only

- **Employee Parking Charge:** A 15% credit for projects that charge employees at least $100/month for parking. This reduction is *not* combinable with the Parking Cash-Out credit.

- **Parking Cash-Out:** A 10% credit for projects that offer employees a cash or transit incentive of at least $100/month not to use a parking space. This reduction is *not* combinable with the Employee Parking Charge credit.

**Enforcement and Monitoring**

To the extent possible, trip reduction credits are designed to be self-enforcing and integrated into the design of the project. However, several measures are more programmatic in nature and will require more careful enforcement. This is particularly true for parking pricing and TDM program measures. Given the trip reduction benefits of these types of “soft” measures, they are important to include, but careful thought needs to be given to enforcement given the financial benefits to developers in pledging to implement them. Several approaches (which are not necessarily mutually exclusive) are possible:

- **Bonding.** For programmatic measures such as parking pricing, developers could be required to post a bond equivalent to the reduction in the Transportation Services Fee. This would be refundable after a specified period (e.g. five years) upon verification that the measures were still in place. This approach is in place in New Castle County, Delaware.

- **Fines/penalties.** Office of Transportation or Code Enforcement staff would conduct spot inspections to verify that TDM measures were still in place. Violations would be punishable by fines if unremediated; an ultimate sanction would be revocation of a use permit. South San Francisco and Cambridge, MA use this type of approach.

- **Substitute measures.** Property owners would be permitted to discontinue TDM measures, but only through substituting other measures with an equivalent trip reduction impact. Seattle uses this type of approach in its Transportation Management Plans.

- **Annual reporting.** Property owners benefiting from trip reduction measures would be required to submit annual reports to the Office of Transportation, verifying that measures were still in place and (if desired) submitting traffic count data.

All of these approaches would require staff resources for enforcement purposes. Transportation Services Fee revenue might be an appropriate source of funding, given the trip reduction benefits of having such programs in place.
# Figure 2  Recommended Trip Reduction Credits

<table>
<thead>
<tr>
<th>Measure</th>
<th>Description</th>
<th>Trip Reduction</th>
<th>Requirements</th>
<th>Comments/Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Project Types</td>
<td></td>
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</tr>
<tr>
<td><strong>Ecopass Program</strong></td>
<td>Free transit passes for all residents/employees</td>
<td>10% neighborhood adjustment</td>
<td>Provide copy of agreement with transit operator(s) to OOT.</td>
<td>Based on neighborhood adjustment, since impact will be greater in areas with good access to transit. Percentage based on Nelson\Nygaard research showing a 9-30% reduction in drive alone rates.</td>
</tr>
<tr>
<td><strong>Car-Sharing</strong></td>
<td>Free car-sharing memberships for all residents/employees. Provide free car-sharing parking (if requested by operator).</td>
<td>2%</td>
<td>1) Provide copy of agreement with car-sharing operator to OOT, including documentation that operator has vehicle(s) within 1/4 mile, or agrees to extend service. 2) Include car-sharing benefits in lease provisions: provide sample lease to OOT.</td>
<td>City CarShare members reduce their driving by 47% after joining (Cervero &amp; Tsai, 2003). Assumes 4% uptake of car-sharing service.</td>
</tr>
<tr>
<td><strong>Secure Bicycle Parking</strong></td>
<td>One Class 1 space per residential unit. For employment uses, required Class 1 spaces calculated as: # employees * neighborhood adjustment * 0.15</td>
<td>1% neighborhood adjustment</td>
<td>Provide site plan with marked locations.</td>
<td>No data available on the impacts of bicycle parking on vehicle travel. Employment requirements intended to ensure more bicycle parking is available in neighborhoods with more bicycle trips. Requirements for Class II bicycle parking are already dictated by City Code.</td>
</tr>
<tr>
<td><strong>Shuttle Service</strong></td>
<td>Project-funded dedicated shuttle service  Partially-funded multi-site shuttle service</td>
<td>3%</td>
<td>Provide copy of agreement with shuttle operator to OOT.</td>
<td>Based on the Valley Transportation Authority (VTA) methodology.</td>
</tr>
<tr>
<td><strong>Proximity to Transit</strong></td>
<td>Location within 1/4 mile of San Pablo Rapid Bus stop</td>
<td>1%</td>
<td></td>
<td>VTA provides 2% credit for major bus stops. Reduced to 1% since this is partly factored in neighborhood adjustment.</td>
</tr>
<tr>
<td>Measure</td>
<td>Description</td>
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<td>Comments/Sources</td>
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</tbody>
</table>
| TDM Program | Select measures from the following list:  
a) Pre-tax commuter benefit program  
b) Guaranteed Ride Home program  
c) Reduced parking fee for carpools/vanpools  
d) Preferential parking for carpools/vanpools  
e) Transit info kiosk, updated at a minimum once a year  
f) Transportation coordinator  
g) Distribution of TDM information package to all residents/employees on arrival plus once a year  
h) Annual transportation fair  
i) Ridematching assistance  
j) Showers, changing rooms  
k) Telecommuting and compressed workweek  
l) Provision of on-site amenities (where these are not available close by)  
m) TMA membership  
n) Other measures not listed, subject to OOT approval | 4 or more measures: 1%  
8 or more measures: 2%.  
12 or more measures: 3%  
Some measures only applicable to non-residential uses | 1) Include measures in lease provisions; provide sample lease to OOT.  
2) Provide site plan, if required to OOT. | Informational measures alone lead to a 1-2% reduction in vehicle trips. Adding services can gain trip reductions of up to 8.5%.  
Source: Based on Schreffler (1996).  
Some of these services (e.g. shuttles) are credited elsewhere in this matrix, therefore reduction is capped at 3%. |
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<tr>
<td><strong>Residential Projects</strong></td>
<td></td>
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<tr>
<td>Housing with Less Parking</td>
<td>Reduced car-ownership housing</td>
<td>Up to 95%</td>
<td>Only for projects with less than 1 parking space/unit, in neighborhoods where project residents will have no access to on-street parking. Provide site plan to OOT and evidence that all on-street parking within 1/4 mile is unavailable to residents (e.g., agreement that they will be ineligible for residential permit parking.)</td>
<td>Assumes 5% of all trips to/from a residential project are visitor/delivery trips and that there will be no spill-over parking issues.</td>
</tr>
<tr>
<td>Unbundled Parking</td>
<td>Unbundling residential parking (charge for parking separate from housing costs)</td>
<td>10%</td>
<td>Monthly fee must be $100/space or more (in 2006 $) Provide sample lease for parking spaces, separate from apartment leases to OOT.</td>
<td>Source: Litman, T (2004) with some modification for Bay Area standards.</td>
</tr>
<tr>
<td><strong>Non-Residential Projects</strong></td>
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<td></td>
<td></td>
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<tr>
<td>Employee Parking Charges</td>
<td>Employee parking fee</td>
<td>15%</td>
<td>Monthly fee must be $100/space or more (in 2006 $) Provide sample tenant agreement and sample employee agreement to OOT.</td>
<td>Based on Nelson\Nygaard research (see Sources page). Conservative estimate to avoid double-counting with other trip reduction elements.</td>
</tr>
<tr>
<td>Parking Cash-Out</td>
<td>Parking cash-out program (employer pays employees not to drive to work)</td>
<td>10%</td>
<td>Monthly incentive must be $100/space or more (in 2006 $) Provide sample tenant agreement and sample employee agreement to OOT.</td>
<td>Conservative estimate derived from Shoup (1997)</td>
</tr>
</tbody>
</table>

**Main sources:**

Kuzmyak, J Richard; Pratt, Richard H and Douglas, G Bruce (2003). *Traveler Response to Transportation System Changes. Chapter 15 – Land Use and Site Design.* Transportation Research Board, TCRP Report 95. [Note that this report has been published on an interim basis in the form of individual chapters.]


NTI — National Transit Institute (2000), *Coordinating Transportation and Land Use Course Manual.* Rutgers University, New Brunswick, NJ.


Schreffler, Eric. "TDM Without the Tedium," Presentation to the Northern California Chapter of the Association for Commuter Transportation, March 20, 1996. Findings from an unpublished study conducted in 1995/96 for the Transportation Cooperative Research Program evaluating the impacts of different trip reduction programs at suburban employers.
Process for Trip Generation Analysis

This section provides a step-by-step process for determining trip generation rates. The spreadsheet provided as a companion to this memorandum automates the majority of these calculations and provides the precise formulae.

1. **Determine land use mix.** The basic input required is the type of land use (e.g. general office or single-family residential), the relevant ITE land use code, and the quantity of development (number of units or square footage).

2. **Determine base trip generation rate.** This is looked up in the ITE Trip Generation manual. Procedures in the Trip Generation Handbook (pp 9-11) should be followed to determine whether to use the regression equation or a weighted average rate. Alternative trip generation sources may be used with the approval of City staff.

3. **Convert to person trips.** ITE trip generation rates refer to vehicle trips, while the adjustment factors relate to the number of people using alternative modes. ITE trip generation rates therefore need to be increased to account for the (small) number of people using alternative modes. The person trip conversion assumes that 10% of the vehicle trips are carpools, average carpool occupancy of 2.25 people, and that other modes (transit, bikes and pedestrians) are equivalent to 5% of the number of person trips by vehicle. (This is equivalent to multiplying the ITE trip generation rate by 1.18.)

Alternatively, other references such as SANDAG’s Traffic Generators manual provide person trips directly.

4. **Estimate proportion of home-based work trips** (for residential uses only). A default of 40% is assumed.

5. **Calculate baseline vehicle trips using neighborhood adjustments.** Multiply the number of person trips by the number of auto trips per person in that neighborhood (equivalent to drive-alone mode share + carpool mode share / 2.25). This needs to be done separately for home-based work trips and other trips.

6. **Calculate additional trip reductions.** Deduct the total percentage reduction from the number of baseline vehicle trips, to account for on-site trip reduction programs.

7. **Estimate reduction for mixed-use development (internal capture).** Internal capture refers to trip-making within a development, and this step deducts trips that are internalized within a project. At a multi-use development including offices and shops, for example, some of the trips made by office workers to banks may occur on-site, and not generate any internal trips.

Guidelines in the Trip Generation Handbook or an alternative reference acceptable to Office of Transportation staff should be used to estimate this reduction.

The mixed-use adjustment does not apply to stand-alone new projects in mixed-use neighborhoods (including downtown), as these trip reductions are already accounted for in the neighborhood adjustment. Guidelines in the Trip Generation Handbook (p. 79) should be used for determining whether it is appropriate to apply an internal capture factor. This specifies that...
central business districts, suburban activity centers, or land uses categories that inherently consist of a mix of uses (e.g. shopping center) do not qualify.

8. **Estimate Pass-By Trips.** Pass-by trips are intermediate stops made by traffic passing the site on an adjacent street. They do not increase traffic. The Transportation Services Fee should not be levied on these types of trips, since they do not represent an overall increase in traffic in the City of Berkeley. However, they should be included in any traffic study, and local mitigation measures or conditions of approval (e.g. to accommodate turning movements) may be required to accommodate them.

Pass-by trips should be estimated based on procedures and data in the *Trip Generation Handbook*. Unless sufficient data are available (either from ITE, other sources approved by City staff, or through local data collection following ITE-recommended procedures), no pass-by trips should be assumed.

Diverted linked trips do add to traffic on local streets, and should not be deducted from the trip generation figures. Figure 3 shows the difference between pass-by and diverted linked trips.

**Figure 3   Pass-By and Diverted Linked Trips**

*Source: Institute of Transportation Engineers, Trip Generation Handbook, p.28.*